ERTS-1 IMAGERY OF THE LAKE CHAMPLAIN REGION

A FIRST LOOK

A. O. LIND

UNIVERSITY OF VERMONT

PRINCIPAL INVESTIGATOR

AND

CO-INVESTIGATORS

E. B. Henson
J. Olson
W. P. Wagner

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IMAGERY AND ANALYSIS PROCEDURE

The first coverage of the Lake Champlain study area, which includes sections of Vermont, New York, and Southern Quebec, was taken by the Earth Resources Technology Satellite (ERTS-1) from July 29 through July 31. The major area of interest (Lake Champlain and adjacent area) was recorded using the RBV (Return Beam Vidicon) sensor while adjacent orbits were covered with the MSS sensor (Multi-Spectral Scanner). The first-look analysis was done using RBV imagery since this was available for the central core of the study area. Positive prints and transparencies (9 inch format) were used with various magnification devices.[1] No color reconstitution or image enhancements were attempted with the first images received. The majority of the comments to follow are based on observations from RBV imagery unless stated otherwise. Interpretations are based on data from each separate image of the available RBV bands.

LAKE CHAMPLAIN

Lake Champlain was cloud-free during the 30 July pass of ERTS-1. RBV images show the lake and adjacent terrain clearly. Small islands less than 100 meters across in any direction could not be readily detected, and shape could not be recognized until island size was up to 200 or 300 meters using the measurements of Juniper Island just west of Shelburne Pt. and Burlington Harbor. Linear patterns identified as fill embankments were easily detected and recognized even though their widths are on the order of only 10 meters. The long, curvilinear embankment extending northwestward from Colchester Pt. is a white limestone-faced embankment as is the U.S. Route 2 embankment at the north end of the study area. (See Fig. 1.) The white limestone face of these embankments provides for a high subject-background contrast, and this is apparently a factor in their fairly conspicuous appearance on the imagery.

For delineating shorelines and recognizing islands, RBV band 3 (IR) was most useful. RBV bands 1 and 2 do not provide sufficient contrast between land and water to clearly define a shoreline, if the terrain is forested.

A first-look analysis of lake tonal signatures in RBV bands 1 and 2 show a relationship which may be

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[1] ERTS-1 image numbers 15110, 15113, 15115.

particularly useful for locating turbidity and algal growth. On the day of the orbit, an intense algal bloom was recorded in the southern part of the lake involving both blue-green algae and diatoms. The bloom shows clearly on the imagery as medium gray in contrast to the darker tones of surrounding waters. Other suspected patches of algae or turbidity on the lake are being mapped and studied and comparisons will be made with existing conditions.

A major tonal difference was observed between the central portion of the lake and the narrow southern arm. A boundary between the highly turbid southern arm and the clear waters to the north could be identified in the vicinity of Chimney Point. This boundary will bear watching on subsequent images to determine changes in lake conditions with season. The nature of the boundary has not been mapped previously, so the satellite coverage will be of particular value in documenting the changes of this major lake feature.

Other tonal patterns observed in the lake include bottom topography which is best seen on RBV band 2 imagery. In river mouth areas, problems of differentiating bottom reflectance from turbidity in the water may possibly be resolved by the sequential analysis of future patterns in river mouth areas and comparison with known bottom contours as displayed on hydrographic charts and lake survey data.

Numerous subtle tonal differences in the lake outside of the areas examined above remain to be explained, and judgments as to water quality will have to wait for further satellite and ground truth data.

WETLANDS AND RIVERS

The most useful imagery for detection and interpretation of wetlands is found in RBV bands 2 and 3 (IR). Large wetland areas at the mouths of the Lamoille and Missisquoi Rivers could be delineated on the basis of their medium gray tonal properties and associated mottled, darker tones related to open water. River floodplain wetlands associated with meander scars could also be delineated; however, smaller wetlands were not readily detectable. These may show later as the vegetative cover changes with the march of seasons.

The major regional rivers, such as the Winooski, Lamoille, and Missisquoi, are readily

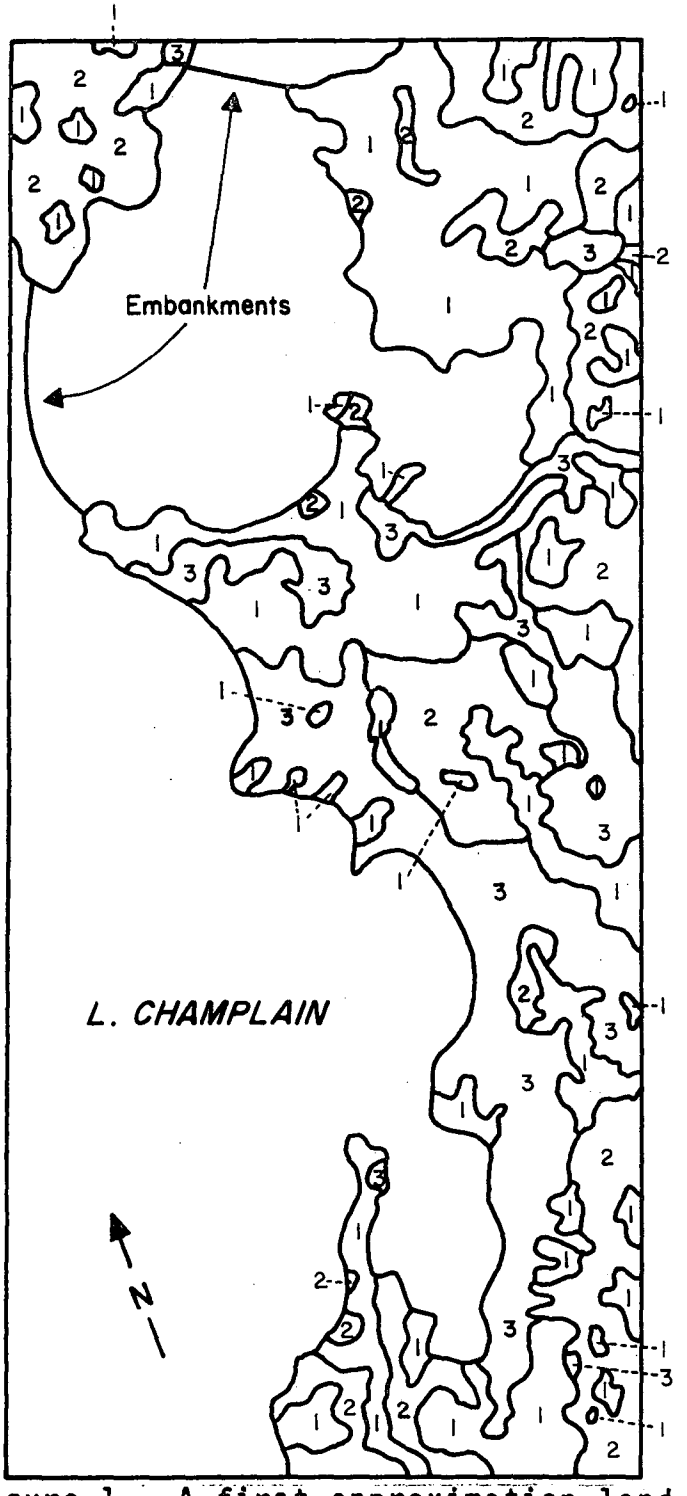

Figure 1. A first-approximation land-type map of the Burlington study area derived from RBV band 2 imagery of 30 July 1972, enlarged to a scale of approximately 1:143,000. The land-types identified on the maps are keyed as follows:

(1) Woodland
(2) Open Land
(3) Built-up Area

detectable and can be traced on RBV band 3 (IR imagery. On imagery in the other RBV bands, fluvial features are extremely difficult, if not impossible, to trace. These conditions are expected to change with the change in seasonal vegetative cover.

SURFICIAL MATERIALS AND TERRAIN

Due to cloudiness in interior sections of Vermont, features close to the lake and to the north, in Quebec, were examined. On the basis of land-use patterns, it was possible to trace the trends of two ice marginal deposits of moraine - like character, namely the Drummondville and Highland front deposits which were related to Laurentide glacial activity. The trend of these ridge-like deposits is in a general NE-SW direction, and patterns associated with them seemed to extend somewhat beyond their presently defined boundaries into the northern-most area of Vermont. The extent of these deposits remain to be investigated. The imagery suggests a somewhat greater extent than previously thought. As with most other terrestial features, RBV band 2 was the most useful of the three bands.

Among other terrain features identified from band 2 imagery, the former shoreline of the Champlain Sea in the St. Albans-North Hero study area could be readily identified and again the trend of the feature suggests a somewhat greater extent than formerly recognized. The identification of features like those above is expected to generate information of particular interest regarding such resources as ground-water and surficial materials.

LAND USE

A first-look at terrestial tonal patterns in RBV band 2 imagery provided a considerable amount of information. A first approximation, land-type map was generated for the Burlington study areas using three categories: (See Figure 1) (a) Woodland, (b) Open Land, and (c) Built-up Area. These were based on tone/pattern elements such that categories (a) through (c) represent a tonal scale from darker to lighter gray with pattern elements ranging in the same manner from irregular massive to rectilinear-patchy. An estimate of inclusion error for the categories above amounts to about 20 percent (i.e. in any one category, there may be as much as 20 percent area in the other two

categories). It is expected that more specific land-use information will be derived so that the above categories will be subdivided further. For example, open land may be divided into agricultural and natural open areas (grasses, scrub).

With respect to agricultural lands and crops, tone differences could be detected among certain larger fields; however, due to the small field sizes prevalent in Vermont, a considerable omission error is likely to occur unless seasonal change patterns aid substantially in tonal renditions of individual fields. The omission error and specific tone-crop type relationships will require further investigations involving close correlation with ground information and imagery from NASA supporting aircraft.

In confronting the problem of depicting mapable information such as land type categories presented in Figure 1, a relatively simple, rapid, technique was employed using Polaroid MP-3 copy camera equipment. Selected areas of interest on the 9 inch positive transparency were photographed with enlargement lenses over a portable light box. In spite of considerable enlargement (to a scale of nearly 1:143,000) little or no loss of contrast was noted and mapping units were readily identifiable. Acetate overlay was placed over the polaroid print and boundaries drawn based on tone/pattern recognition. This technique may prove to be particularly useful for other phases of the study since its assets are simplicity and rapid production of a usable mapping tool. The map presented in Figure 1 was derived using an enlargement of the Burlington study area and has the various distortions associated with bulk processed RBV imagery. However, these distortions do not seem to detract from the results since the small area photographed for analysis was found to fit present topographic map outlines very closely.

SUMMARY OR SIGNIFICANT RESULTS

A first-look analysis of RBV imagery (30 July) of Lake Champlain and adjacent areas provided the following information on land and water resources of the Lake Champlain region and Vermont. The numbers in parentheses adjacent to each item listed below correspond to the RBV bands used for detection, identification and interpretation.

A. Lake Champlain

1. Location and shape of islands over 200 meters at narrowest part. (3).
2. Location of man-made structures (fill embankments) at least 10 meters across (2, 3).
3. Location of shoreline. (3)
4. Identification of algal blooms (blue—green algae and diatoms). (1, 2).
5. Identification of major turbidity boundary. (1, 2).
6. Identification of lake bottom features in sandy, shallow areas. (2).

B. Wetlands and Rivers

1. Identification of major lake shore wetland areas. (2, 3).
2. Identification of floodplain wetlands (meander scars). (3).
3. Location of major streams. (3).

C. Surficial Materials and Terrain Features

1. Identification of ice marginal deposits of major proportions. (2).
2. Identification of former shorelines of the Champlain Sea. (2).

D. Land Use

1. Identification of wooded areas. (2).
2. Identification of open land. (2).
3. Identification of built-up areas. (2).
4. Mapping of the above 3 categories for the Burlington Study area. (2).

A technique for generating a useful mapping tool (scale about 4 times greater than 9 inch ERTS image) was developed using Polaroid MP-3 equipment. Rapidity and simplicity are assets of the technique. Quality of these enlargements was found to be excellent.